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Research Article

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Cardiac Health Monitoring and Alert System Using IOT

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Abstract
The project presents an IoT-based cardiac monitoring and alert system which mainly focuses for the gym and sports environments to witness safe and enhanced workouts and progress. The system includes ECG, PPG, SpO_2 sensors with a microcontroller for continuous cardiac monitoring. It analyzes the Heart Rate Variability (HRV) using time and frequency domain evaluation to detect arrhythmias, cardiovascular stress, muscle fatigue, dehydration, and abnormal vital conditions during exercise. The Real-time data is transferred to a cloud platform for analysis, allowing instant alerts to trainers or the persons in case of any variation. The motion during the workouts, improved straining techniques assure safe measurements. The proposed cardiac monitoring system improves gym and sports safety by handling fast, real-time cardiac monitoring, early risk finding, and performance improvement.

Keywords: Internet of Things (IOT), Cardiac Health Monitoring, Wearable Accessories, Sensors, Heart Rate Variability, Cardiovascular Disease

1.Introduction

The proposed system mainly focuses on live heart rate and the frequent participation in the gym and sports activities plays a vital role in preserving cardiovascular fitness, muscular strength, and overall physical well-being. Observing physical parameters during exercise is required to assure safety and improve performance. Among different vital parameters, heart rate and Beats Per Minute (BPM) are the most fundamental indicators of cardiovascular response to physical activity. Continuous observing of heart rate during workouts helps in maintaining optimal training zones, preventing strain, and reducing the risk of exercise-reduce cardiac difficulty. In recent years, updates in Internet of Things (IoT) technology have empowered the development of real-time health monitoring systems using wearable and embedded sensors. The interconnection of physical devices through IoT allows for the collection, processing, and transmission of data via wireless networks. For example, in fitness and athletics, IoT systems provide a convenient method of obtaining real-time heart rate information which can then be sent to a coach, mobile app, or cloud dashboard for analysis and visualization. Traditional fitness monitoring relies on a separate device that provides heart rate data locally without the ability to store data or access it remotely. Also, traditional fitness monitoring does not include real-time alert capabilities or centralized monitoring capabilities. An IOT based heart rate monitoring system integrates a heart rate sensor, microcontroller, and wireless communication module. The heart rate monitor continuously provides BPM data during a workout and sends the continuously collected data to a connected platform. Real-time heart rate monitoring (BPM) system provides immediate feedback for blood pressure levels and alerts when BPM exceeds acceptable limits.

BPM capabilities are very useful in gym and athletic sports, the system is designed to help an athlete/trainer monitor, maintain, and improve their ability to stay within their desired target heart rate zone throughout their endurance (or other) training, ultimately when training at high levels of intensity, the accuracy and effectiveness of your workouts can be improved through continuous and precise BPM recording, as such, this allows you to create individualized training programs that are based on your real-time BPM data and analysis. Thus, when IoT is combined with heart rate monitoring technologies, there is an effective, efficient, and cost-effective way of monitoring heart function (cardiac) in "real-time" and provides a solution for safe workout environments, data-driven assessments of performance, and improved health care for those who participate in physical activity.

2. Literature Survey

Rapidly expanding markets for both wearable device markets and IoT-based product lines have greatly impacted the creation of new solutions for continually monitoring human physiology during physical exercise/sports use [1]. Numerous research papers have documented ways to monitor heart rates using many different sensing technologies, communication protocols, and processing methods. Section 2 will summarize previous research conducted within the literature focusing on the use of IoT to monitor heart rates and beats per minute (BPM) in gyms or during sporting events.

2.1.Wearable Heart Rate Monitoring Systems

The methods of monitoring heart rate early on primarily used electrocardiography (ECG) to capture accurate electrical signals from the heart. Although ECG provides accurate measurements, multiple electrodes must be attached to obtain accurate results, which reduces the comfort for continuous wear during intense activity. Due to these limitations, PPG based monitoring devices designed to provide heart rate data in real-time were developed and are compact, cost-efficient, and allow for continuous monitoring during athletic activities. While research supports the ability of PPG sensors to provide accurate heart rate data when movement is controlled, the accuracy of the results deteriorates as a person's body moves during vigorous activity [2]. Hybrid systems that combine both ECG and PPG technologies are currently in development to achieve both high levels of precision and user comfort. The improvements in both ECG and PPG-based devices allow for a much more dependable means of tracking your heart health over a prolonged time than by using traditional cardiac monitoring systems. Improvements in low-power design have made hybrid cardiac monitoring devices significantly less power hungry and can provide extended usage times for users utilizing continuous monitoring capabilities.

2.2. IOT-Based Health Monitoring Systems

IOT-based healthcare systems have been widely studied for remote patient monitoring. These systems consist of biosensors, a microcontroller (such as Arduino or ESP-based boards), and wireless communication modules (Wi-Fi or Bluetooth) for real- time data transfer. Research demonstrates that IoT structures improve constant monitoring, enable cloud storage, and support remote access to physical data [3]. Several investigations proposed IoT systems for monitoring heart rate, body temperature, and oxygen saturation in medical uses. These systems use cloud platforms for data imaging and analysis. While most existing works focus on clinical or elderly care surroundings, limited research specifically handles real-time heart rate monitoring tailored for gym and sports activities.

2.3. Real-Time Data Transmission and Cloud Integration

Recent literature highlights the importance of real- time data transmission in fitness monitoring systems. Cloud-based platforms allow continuous storage, and data analysis. Researchers have implemented IoT dashboards that display live BPM values and generate alerts when abnormal thresholds are detected [4]. Studies also highlight the role of mobile application in providing instant feedback to athletes and trainers. Real-time alerts and data help prevent overtraining and reduce the risk of cardiovascular strain. However, objections such as network latency, data security, and power consumption remain key research studies.

2.4. Heart Rate Monitoring in Sports and Fitness Applications

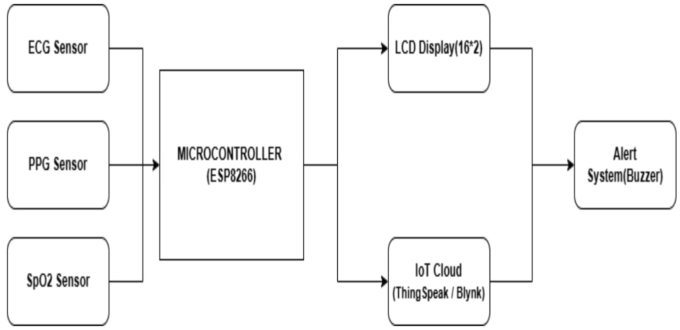
Heart rate monitoring is widely used in sports science to identify different training zone intensities such as resting, moderate, and maximum heart rates. Studies have shown that staying within target heart rate zones enhances exercise effectiveness and cardiac efficiency. Automated IoT-based systems for heart rate monitoring will provide both real-time tracking of exercise intensity and objective assessment of the individual's performance. Some have proposed a "smart gym" environment where physiological data is collected by sensors to enable the automatic adjustment of workout levels according to actual physiological performance data [5]. However, many existing IoT heart rate monitoring systems are complex and monitor many variables, which drives up the implementation cost and overall complexity. Hence, there is a need for an inexpensive, user friendly IoT heart rate monitoring system designed specifically for real-time heart rate measurement and beats per minute (BPM) measurements for gym patrons.

2.5. Research Gap

While there is a great deal of work done in both wearable health monitoring devices and IoT-based medical systems, very little work has been done to specifically monitor heart rates and BPM live while exercising in a gym and sports environment. Most systems available today have either been focused solely on monitoring patients clinically or have too many different physiological parameters that increase costs and reduce their practicality to be used daily for fitness reasons [7]. Therefore, there is clearly a need for a system that utilizes IoT to monitor heart rate and BPM accurately as well as provide real-time collection, wireless transmission, and live monitoring of data while exercising in either a gym or sporting event [6]. The designed system will fill this void by developing an inexpensive, flexible, and simple monitoring solution that focuses solely on improving workout safety and performance tracking through the use of technology.

3. Methodology

Microcontroller that will collect, process and transmit physiological data in real time. The methodology consists of five (5) main steps: data acquisition, signal conditioning, feature extraction, wireless transmission, alert generation. Multiple biosensors will be utilized in the first step (data acquisition) to improve measurement accuracy and safety.



The Electrical Heart Signal (ECG) Sensor: The ECG sensor measures the electrical activity (cardiac waveforms) of the heart by detecting its waveform and using the R-peaks to calculate R-R intervals, which are necessary for accurate Heartbeats per Minute (BPM) measurement. ECG sensors provide medical-grade measurement of heart rate variability, as well as assisting with identifying cardiac irregularities during exercise or high-intensity workouts [8]. The Photoplethysmogram (PPG) sensor is both incredibly useful as well as wearable, however, due to the motion of the user during gym activities, it is less accurate than the ECG for motion-detecting objects. Consequently, the ECG sensor serves a validation function by increasing the accuracy of the entire system [9]. The SpO_2 sensor indicates blood oxygen levels and assists in ensuring proper blood oxygenation levels. When an individual is engaged in high-intensity physical activities such as weight training or sprinting, the individual may start to become fatigued, develop respiratory problems, or become stressed if the individual's SpO_2 levels drop. In addition, the addition of a Flex sensor aids in identifying how the body is bending and moving [10]. The Flex sensor additionally correlates changes in heart rate with the intensity of exercise, and to help discriminate between normal exertional heart rate and abnormal cardiac response. In the signal conditioning stage, the analog signals from the ECG, PPG and Flex sensors are brought into the ADC pins of the Microcontroller (ESP32/ESP8266). Throughout this process, filtering techniques are applied (including low-pass filters and moving average filters) to eliminate electrical signal interference, reduce noise, and eliminate motion interference. Peak detection algorithm is used to measure heart rate precisely. The BPM is calculated using the below formula: $BPM = 60\ /RR\ Interval(s)$

PPG detects pulse peaks, converts these pulses into the BPM value, SpO_2 levels are evaluated through pulse oximetry by taking absorption measurements from red and infrared light passing into arterial (blood) tissues [10]. Measuring SpO_2 continuously allows for the detection of sudden drops in oxygen saturation levels (saturation) [11]. Real-time data processing provides real-time user feedback during exercise sessions, therefore providing timely and accurate health monitoring information in dynamic gym and athletic sports activities.

S. NO	Parameter	Existing System
1	Sensors used	Mostly single PPG Sensor (fitness band)
2	ECG Monitoring	Not Available
3	SpO2 Monitoring	Limited or Optional
4	Movement correlation	Not Integrated
5	Accuracy	Moderate, affected by motion artifacts
6	Data Display	Local screen display only
7	IoT Connectivity	Limited or not available
8	Real-Time Alerts	Basic notification only
9	Medical Reliability	Not medical-grade
10	Application Focus	General fitness tracking

Table I: Existing System Analysis

The secondary step of discussion entails using wireless communication to transmit captured data to the IoT cloud via Wi-fi. The following data are transmitted: heart rate (BPM) from heart monitor devices, pulse oximeter % SpO_2, and movement intensity based on flex sensor readings. The data is presented in real-time through a dashboard that can be seen by all trainers and users in the gym. All actual values of the data collected will remain recorded for easier tracking of individual performance and more accurate evaluations of performance. In addition, a safety device is part of the IoT system [12]. There are sets of threshold values for heart rates and oxygen saturation levels. When a heart is detected above an indicated target zone or when an oxygen saturation level falls below a specified minimum threshold, an alert notification is automatically generated by the IoT system through the user's mobile application. By notifying this way, the IoT system enables rapid response to reduce the likelihood of excessive stress on the heart and/or physical injury. Overall, the methods outlined allow an accurate, real-time, and multidimensionally measured system for gym and sports applications [13]. Historical analytic reports allow for the long-term tracking of fitness trends and cardiovascular improvement, while the storage of physiological data in a secure cloud system gives users the benefit of having all of their physiologic data recorded and saved for future medical assessments.

S. NO	Parameter	Proposed System Description
1	Sensors Used	ECG+PPG+SpO2 sensor
2	ECG Monitoring	Real-time cardiac waveform analysis
3	SpO2 Monitoring	Continuous oxygen level tracking
4	Movement Correlation	Not Integrated
5	Accuracy	High (sensor fusion technique)
6	Data Display	Cloud + Mobile dashboard
7	IoT Connectivity	Wi-Fi enabled real- time transmission
8	Real-Time Alerts	Automatic abnormal threshold alert
9	Medical Reliability	Improved reliability with ECG validation
10	Application Focus	Gym and sports- specific cardiac monitoring

Table 2: Proposed System Features

4. Output

The assessment of performance, response speed, and sensor precision of the predictive IoT real-time heart rate monitor for gym and sports activities was done on real people with dynamic workouts [14]. This system provides a means of continually monitoring the heart rate and body movement by means of ECG, PPG, and SpO_2 sensors and transmits that data to a cloud platform for near real-time viewing. Actual physical evidence indicates that data from high-intensity activities is stored permanently within this system.

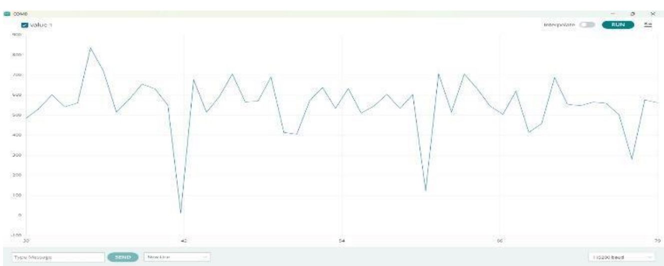


Figure 1: ECG Signal Graph 1

Overall, physical activity-related signals appear to have been transmitted with low signal distortion. The normal transmission time (end to end) appears to be well within an acceptable limit for real-time monitoring, thus allowing for timely user and trainer feedback. An analysis of the accuracy of the sensors indicated that the ECG and PPG sensors performed well (high correlation) when compared with device reference standards found within a clinical setting, while SpO_2 values were also found to be in an acceptable range for clinical uses [15]. Moreover, due to its design, the sensor is able to capture changes in motion very accurately and allows the monitoring of both physical activity and cardiovascular responses at the same time. The secure cloud-based architecture provides real-time synchronization and remote access to lifecycle data for safe storage in a secure environment. The evidence supports this conclusion as the proposed system is secure, has a fast response time, and provides real-time cardiovascular monitoring of athletes during exercise, fitness and remote medical activities. Testing of the system's response time has assessed the direct relationship between the number of devices connected to the system and the corresponding increase in reaction times [16]. A marked increase in reaction times was observed to occur with the number of devices connected, it was also seen that the larger the number of devices involved in the testing, the greater the increase in reaction times were due to network congestion and cloud processing overhead. In addition, the system has provided consistently reliable communications between devices without data loss, confirming its potential for scalable use in gyms. Additionally, should the system detect an individual's heart rate or SpO2 level to be abnormal, it will provide immediate alerting to the user in order to reduce their risk of harm while performing physical activity.

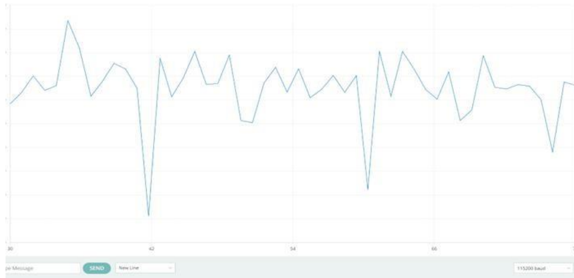


Figure 2: ECG Signal Graph 2

The system recorded the variance in heart rate that was dynamic, through an assessment that was done with an equal measure of exertion during simulated exercise activity. These heart rates, in the Interphase section were found to be between 60 and 100 beats per minute (bpm). At high intensity, the bpm increased to approximately 100 to 110 bpm, providing the expected feedback to the body as it was undergoing physical strain. During the Interphase portion, the heart rates gradually returned to near normal range [17]. The electrocardiogram (ECG) sensor consistently provided accurate and robust readings for every session, and also captured heart rate with great efficiency via the photoplethysmogram(PPG) sensor, with some minimal variations of the heart rate due to minor motion-induced artifacts. Filtering techniques were used to reduce the observed variations caused by motion. Sensor accuracy was calculated using two means of comparison with a control (reference) measurement. This ECG sensor provided around 80-98% accuracy, which means that it is able to obtain cardiac signals reliably [18]. The PPG sensor yielded around 90-95% accuracy, and the SpO_2 sensor had an approximate accuracy of 86-94% for measuring oxygen saturation levels during exercise and establishing a link between physical activity and heart rate variance.

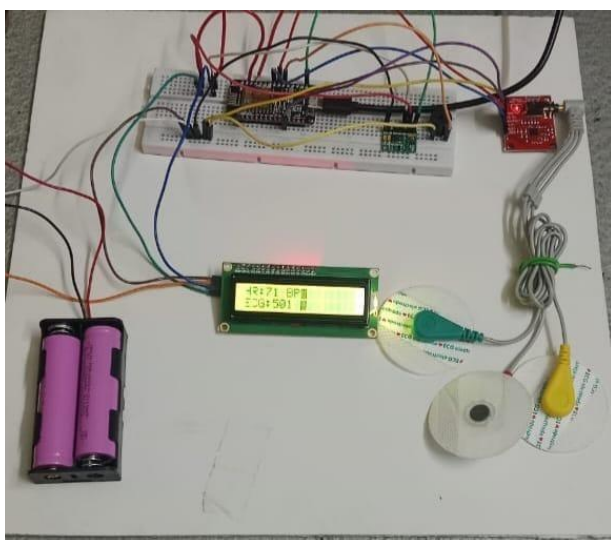


Figure 3: Output: Hardware Setup

The overall system provided durable functions, continuous data collection/receiving, and stable wireless transmission. The proposed system improved workout safety through the successful activation of threshold-based alerts for creating BPMs higher than safe limits. The proposed system provides live monitoring of heart rate, promotes safe physical activity through sports and gyms, and allows for real-time tracking of health and a proper response time with high levels of reliability [18]. Furthermore, the proposed system could be greatly improved if additional sensors such as SpO2 and ECG were to be incorporated to provide an even more comprehensive understanding of the components of cardiovascular health. Data obtained over time will be accessible through a cloud platform for long-term study and trend analysis. In conclusion, the proposed system represents significant contributions to preventative health care through facilitating timely medical intervention and enhancement of patient safety. Furthermore, advanced algorithms can be implemented to provide early detection of cardiac abnormalities, to limit the total number of alerts.

References

1. Rassam, M. A. (2024). Autoencoder-Based neural network model for anomaly detection in wireless body area networks. *IoT, 5*(4), 852-870.
2. Iqbal, S. M. A., Leavitt, M. A., Mahgoub, I., & Asghar, W. (2024). A wearable internet of things device for noninvasive remote monitoring of vital signs related to heart failure. *IoT, 5*(1), 155-167.
3. Al Khatib, I., Shamayleh, A., & Ndiaye, M. (2024, July). Healthcare and the internet of medical things: Applications, trends, key challenges, and proposed resolutions. In Informatics (Vol. 11, No. 3, p. 47). MDPI.
4. Bolam, S. M., Batinica, B., Yeung, T. C., Weaver, S., Cantamessa, A., Vanderboor, T. C., ... & Monk, A. P. (2021). Remote patient monitoring with wearable sensors following knee arthroplasty. *Sensors, 21*(15), 5143.
5. Li, C., Wang, J., Wang, S., & Zhang, Y. (2024). A review of IoT applications in healthcare. *Neurocomputing, 565*, 127017.
6. Molinari, G., Molinari, M., Di Biase, M., & Brunetti, N. D. (2018). Telecardiology and its settings of application: An update. *Journal of telemedicine and telecare, 24*(5), 373-381.
7. Xu, X., Liu, Z., He, P., & Yang, J. (2019). Screen printed silver nanowire and graphene oxide hybrid transparent electrodes for long-term electrocardiography monitoring. *Journal of Physics D: Applied Physics, 52*(45), 455401.
8. Campero Jurado, I., Lorato, I., Morales, J., Fruytier, L., Stuart, S., Panditha, P., ... & Brombacher, A. (2023). Signal quality analysis for long-term ECG monitoring using a health patch in cardiac patients. *Sensors, 23*(4), 2130.
9. Mahmud, M. S., Wang, H., Esfar-E-Alam, A. M., & Fang, H. (2017). A wireless health monitoring system using mobile phone accessories. *IEEE Internet of Things Journal, 4*(6), 2009-2018.
10. Tooley, J. E., & Turakhia, M. P. (2022). Is it time for a consumerized or home-based 12-lead electrocardiogram?. *EP Europace, 24*(3), 357-358.
11. Wan, J., AAH Al-awlaqi, M., Li, M., O'Grady, M., Gu, X., Wang, J., & Cao, N. (2018). Wearable IoT enabled real-time health monitoring system. *EURASIP Journal on Wireless Communications and Networking, 2018*(1), 1-10.
12. Li, C., Hu, X., & Zhang, L. (2017). The IoT-based heart disease monitoring system for pervasive healthcare service. *Procedia computer science, 112*, 2328-2334.
13. Mian Qaisar, S., & Subasi, A. (2020). Cloud-based ECG monitoring using event-driven ECG acquisition and machine learning techniques. *Physical and Engineering Sciences in Medicine, 43*(2), 623-634.
14. Awaisi, K. S., Hussain, S., Ahmed, M., Khan, A. A., & Ahmed, G. (2020). Leveraging IoT and fog computing in healthcare systems. *IEEE Internet of Things Magazine, 3*(2), 52-56.
15. Rincon, J. A., Guerra-Ojeda, S., Carrascosa, C., & Julian, V. (2020). An IoT and fog computing-based monitoring system for cardiovascular patients with automatic ECG classification using deep neural networks. *Sensors, 20*(24), 7353.
16. Swain, K., Cherukuri, M., Mishra, S. K., Appasani, B., Patnaik, S., & Bizon, N. (2021). LI-Care: A LabVIEW and IoT Based eHealth Monitoring System. *Electronics 2021,* 10, 3137.
17. Jabeen, T., Jabeen, I., Ashraf, H., Jhanjhi, N. Z., Yassine, A., & Hossain, M. S. (2023). An intelligent healthcare system using IoT in wireless sensor network. *Sensors, 23*(11), 5055.
18. Uddin, R., & Koo, I. (2024). Real-time remote patient monitoring: a review of biosensors integrated with multi-hop IoT systems via cloud connectivity. *Applied Sciences, 14*(5), 1876.